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Electron paramagnetic resonance study of rotational mobility of vanadyl porphyrin complexes in crude oil asphaltenes: Probing the effect of thermal treatment of heavy oils

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Abstract

©2014 American Chemical Society. The structural properties of crude oils and asphaltenes, especially related to the dynamics of their aggregation, have been investigated by different experimental and theoretical methods during the last few decades. However, there are only a few works devoted to study the dynamics of asphaltenes in a native hydrocarbon environment. In this report, we illustrate a possibility to use electron paramagnetic resonance (EPR) spectra of vanadyl porphyrins in asphaltenes for the qualitative and quantitative analysis of their rotational mobility in the crude oil samples. On the basis of the simulation of the EPR spectra, a simple semi-empirical parameter sensitive to the transition between motional regimes is proposed. This mobility parameter can be potentially useful for the prediction and analysis of the thermal influence on heavy oil reservoirs during hydrocarbon production. It is found that the rotational correlation time of the complexes in heavy oil samples changes discontinuously with the temperature. The observed jump could be attributed to a disaggregation of supramolecular complexes of asphaltenes in the close vicinity of a phase transition.